

Comment: Total Factor Productivity

The measurement of total factor productivity (TFP) shows the efficiency with which all inputs are utilized in a production function. Whereas a partial productivity index measures the value of output per unit of input, the TFP index sums the partial productivities of all inputs in the production process.

Both input growth and TFP growth contribute to output growth simultaneously. The purpose of measuring TFP is to separate these two forces contributing to growth in output. The estimate of TFP change is derived from a production function that gives the maximum amount of output that can be produced with a given amount of input. The structure of production implied by the production function requires that the following accounting identity hold:

Percentage change in total factor productivity \equiv percentage change in output *minus* [percentage change in inputs *multiplied* by elasticity of output with respect to inputs].

The percentage change in output and in inputs between any two periods can be obtained from standard economic statistics. The elasticity of output with respect to each input—that is, the percentage increase in output that is achieved from a 1 percent increase in the input—can be obtained econometrically from the production function. The second term on the right-hand side of the identity therefore measures the percentage change in output made possible by the increase (or decrease) in inputs. Any increase (or decrease) in output that occurs in addition to this is due to TFP change. “TFP change” is often used synonymously with “technical change,” as represented in Exhibit II.1 by a shift in the production function so that the efficiency with which all inputs are combined in production increases.

In a pioneering article—“Technical Change and the Production Function,” *Review of Economics and Statistics* (August 1957)—Nobel laureate Robert Solow explained the neoclassical growth equation and showed how to segregate increases in output per head due to “technical change” (that is, a shift in the production function) from those due to changes in the availability of capital per head.

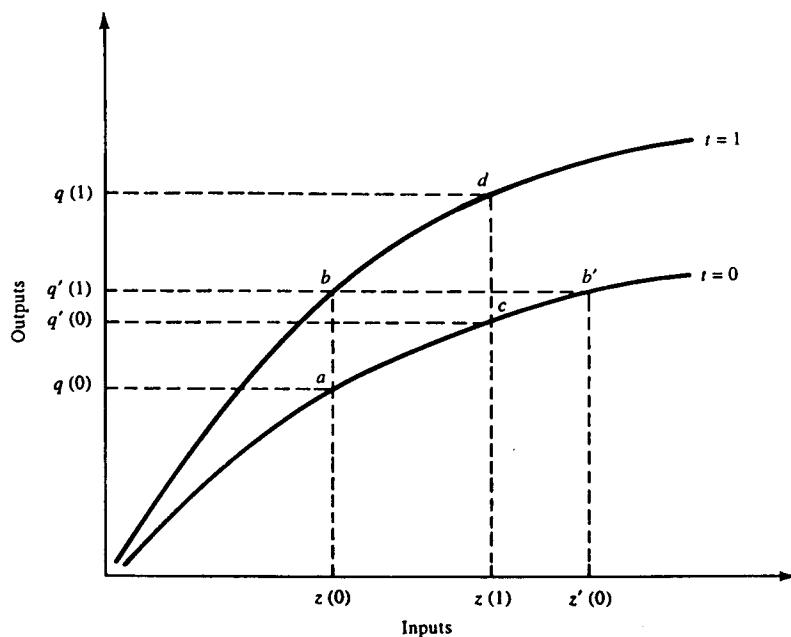
EXHIBIT II.1. Technical Change and the Production Function

Exhibit II.1 depicts two production functions, each corresponding to a different level of technology: $t = 0$ and $t = 1$. A given level of technology, say at $t = 0$, implies that more output—for example, $q'(1)$ at production point b —cannot be produced without more inputs. To produce $q'(1)$ with technology $t = 0$, inputs would have to be increased to the level $z'(0)$ corresponding to production point b' .

If Total Factor Productivity or TFP increases, this means that greater output can be produced over time with given levels of inputs. Exhibit II.1 shows the production function to have shifted upward from $t = 0$ to $t = 1$. This shift represents a technical change, resulting in a larger amount of maximum output that can be produced at every level of inputs. It is now possible, for example, to produce the amount of output $q'(1)$ with the input level of $z(0)$ rather than $z'(0)$ at production point b . Thus the technical change represented by the shift in the production function means that the efficiency with which all inputs are combined in production increases. This is the definition of an increase in TFP.

EXHIBIT II.2. Sources of Growth**A.** The Growth of GDP, Inputs, and TFP (percent)

Region, Group, or Economy	GDP			Capital			Labor			TFP		
	1960– 73	1973– 87	1960– 87	1960– 73	1973– 87	1960– 87	1960– 73	1973– 87	1960– 87	1960– 73	1973– 87	1960– 87
Developing economies												
Africa	4.0	2.6	3.3	6.3	6.3	6.3	2.1	2.3	2.2	0.7	–0.7	0.0
East Asia	7.5	6.5	6.8	9.8	10.7	10.2	2.8	2.6	2.6	2.6	1.3	1.9
Europe, Middle East, and North Africa	5.8	4.2	5.0	7.7	7.5	7.6	1.4	1.9	1.7	2.2	0.6	1.4
Latin America	5.1	2.3	3.6	7.4	5.6	6.3	2.5	2.8	2.6	1.3	–1.1	0.0
South Asia	3.8	5.0	4.4	8.0	7.2	7.7	1.8	2.3	2.1	0.0	1.2	0.6
Sixty-eight economies	5.1	3.5	4.2	7.4	7.1	7.2	2.2	2.4	2.3	1.3	–0.2	0.6

EXHIBIT II.2. (continued)

B. Percentage Share of Output Growth Accounted for by Factor Input Growth, Sample of World Economies, 1960–87

Region or Group	Capital	Labor	TFP
	1960–87		
Africa	73	28	0
East Asia	57	16	28
Europe, Middle East, and North Africa	58	14	28
Latin America	67	30	0
South Asia	67	20	14
Total	65	23	14

One method of analyzing the growth process is to estimate the contribution that the inputs of capital and labor make to growth in GDP. The sum of the contributions of the factor inputs does not account for overall growth. The residual in the estimated production function, or total factor productivity (TFP), accounts for the rest, as indicated above for different developing economies.

Source: World Bank, *World Development Report 1991* (1991), pp. 43, 45.